



ORIGINAL ARTICLE

Efficacy and safety of a single treatment using a 10,600-nm carbon dioxide fractional laser for mild-to-moderate atrophic acne scars in Asian skin

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ABSTRACT

Background: Ablative laser therapy with carbon dioxide is effective for acne scars; however, the long downtime limits its use, especially in types III and IV skin. The fractional ablative 10,600-nm carbon dioxide laser system reportedly maximizes efficacy and minimizes side effects. The goal of this study was to evaluate the efficacy and safety of an ablative 10,600-nm carbon dioxide fractional laser system in a single treatment session on atrophic acne scars in Asian patients.

Methods: Twenty-five patients with atrophic acne scars were enrolled. The laser fluences were delivered using the Deep FX mode. Comparative photographs were taken with VISIA complexion analysis. Physician evaluation and patient satisfaction were graded on a four-point scale.

Results: At follow-up 1 month after treatment, four patients showed 51–75% improvement, 16 had 26–50% improvement, and five had minimal or no improvement. At 3 months, two patients had excellent results (76% and 100% improvement). Postinflammatory hyperpigmentation was present in six of the 25 (24%) patients; by 3 months' follow-up, this had faded in five of six cases.

Conclusion: A single treatment with the carbon dioxide fractional laser system is effective for acne scars in Asian patients, with minimal and acceptable side effects.

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Introduction

Atrophic acne scars cause significant disfigurement, especially on the face.¹ Laser resurfacing is an effective treatment that is easier to use than other treatment modalities such as chemical peeling, surgical excision, punch grafting, dermabrasion, and dermal fillers.²

Ablative laser therapies with carbon dioxide (CO₂) or erbium-doped yttrium aluminum garnet (Er:YAG) lasers are well-recognized for the treatment of acne scars and skin rejuvenation.^{3,4} Fractional photothermolysis systems (mostly using 1550-nm erbium-doped lasers) in the treatment of acne scars have been reported,^{5–8} although CO₂ fractional laser treatment has rarely been compared with traditional ablative CO₂ laser resurfacing in a head-to-head study. One of the disadvantages of traditional laser ablation is the long downtime due to prolonged erythema and postinflammatory hyperpigmentation (PIH), especially in darker-

skinned individuals.^{9,10} Fractional photothermolysis with an ablative 10,600-nm CO₂ laser reportedly has more transient, mild-to-moderate post-treatment side effects.^{11–16} Recovery and the effects of such treatment among Asian patients have been reported to be limited.^{11,13,16}

In this prospective study, a CO₂ fractional laser system with moderate treatment settings was used in a single treatment session for atrophic acne scars in Asian patients. Specific complexion analysis photography was used to assess the outcome in an attempt to more clearly define the efficacy and safety of this procedure in these patients.

Methods

Patients

Twenty-five Asian patients (15 men and 6 women; mean age 30.4 years, range 19–39 years) with mild-to-moderate acne scars (skin types III and IV) were enrolled. The exclusion criteria included pregnancy, lactation, immunosuppression, isotretinoin use, and/or a history of keloid scarring.

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None of the patients reported a history of herpes virus infection or used any prophylactic antiviral medication. No other ablative resurfacing or filler injections had been performed in the 6 months preceding this study.

Atrophic scars were classified into four types, with most patients having three or four types: shallow atrophic scars in 14 cases, (56%), boxcar scars in 17 (68%), rolling scars in 10 cases (40%), and ice-pick scars in six cases (24%). The treatment area included the cheeks in 24 patients and the nose only in one patient.

Treatment

The areas to be treated were first cleansed with a mild cleanser and 70% alcohol. Topical anesthesia with 2.5% lidocaine and 2.5% prilocaine cream (EMLA) was applied 60 minutes before initiating treatment. A single session of CO₂ fractional photothermolysis using a 10,600-nm UltraPulse (Encore laser; Lumenis Inc., Santa Clara, CA, USA) was delivered using the Deep FX mode with settings of 12.5–15 mJ, density 2–3, and frequency 300 Hz.

Immediately after treatment, ice packs were applied for at least 10 minutes to relieve burning. An occlusive dressing (Duoderm, ConvaTec, USA) was applied to the treated areas and was changed daily for the first 2 days. After the 2nd day, a moisturizer (Phase O total care; Phasilab, France) was applied liberally, and a broad-spectrum sunscreen was recommended for daily use to avoid overexposure to sunlight.

Evaluation

Digital photographs were taken and analyzed using VISIA Complexion Analysis (Canfield Scientific, Inc., Voorhees, NJ, USA) to establish the numbers of pores (including follicular openings and atrophic scars) and skin texture scores at baseline, 1 week, 1 month, and 3 months after treatment. The region of interest for each image was defined in the same way for all images using predefined landmarks on the face and was analyzed using customized software that automatically identified and quantified features such as texture, score, wrinkles, pigment, and redness. The details for each skin feature were indexed, which allowed comparison between the same patient at different points in time as well as between patients. VISIA identified large follicular openings and atrophic scars as pores and recognized peaks and valleys on the skin surface to analyze skin texture, thus reflecting skin smoothness. VISIA scores were available for all but the patient whose treatment was limited to the nose.

In addition to VISIA analysis, two dermatologists independently compared the digital photos for clinical evaluation of the acne scars. A four-point scale was used: Grade 1, <25% improvement; Grade 2, 26–50% improvement; Grade 3, 51–75% improvement; and Grade 4, >75% improvement. Patients used a similar four-point scale to indicate their degree of satisfaction with the results. Side effects of treatment, including crusting or scaling, erythema, pigmentation, acne, or pruritus, were reported on follow-up.

Statistical analysis

Variables measured at different time points were compared using the Wilcoxon signed-rank test. A value $p < 0.05$ was considered statistically significant. SAS 9.0 software (SAS Institute Inc., Cary, NC, USA) was used to perform the statistical analysis.

Results

On clinical assessment by the physicians, the majority of patients scored Grade 1–2 improvement at 1 month, although none achieved Grade 4. The mean grade of improvement at 1 month over

baseline was 1.96 (Table 1, Figure 1). After 3 months, the mean improvement in grade over baseline was 2.41 (Table 1, Figure 2), although eight patients did not return for follow-up at that point. Age, sex, and scar type did not significantly affect the improvement in grade.

The patients tended to see less improvement than the physicians. Again, none reported Grade 4 results at 1 month, but two did at 3 months. At that point, however, seven were still reporting only Grade 1 results (Table 2). Of the eight patients who did not come back for follow-up 3 months after treatment, six could be contacted by telephone (all of whom had reported Grade 1 for their scarring at the 1-month follow-up) and stated that the results remained the same at 3 months. These results are included in Table 2.

Compared to baseline, the 1-month VISIA scores for skin texture and pores were significantly decreased; however, the residual redness score was significantly increased. Again compared to baseline, the 3-month scores revealed no significant differences, with the exception of a significant increase in the left pore score. No significant differences were found in wrinkle, pigment, and porphyria scores (Table 3).

Nine patients had erythema at 1 month, seven showing Grade 1, and two Grade 2, erythema. Three of these patients still had Grade 1 erythema at 3 months, a statistically significant improvement overall ($p = 0.031$). Six patients had Grade 1 PIH at 1 month, but this had almost faded in all except one case at 3 months. Pruritus was present in three patients at 1 month; they reported that this gradually subsided over the next 2 months, although they still had dry scaly surfaces over the treatment areas at the final follow-up. Patients graded their skin texture as worse at 3 months post-treatment than at 1 month post-treatment ($p = 0.039$). Eight patients (32%) had higher skin texture grades at 3 months than at 1 month. Three patients had a flare-up of acne 1 week after treatment.

Discussion

With one treatment of this CO₂ fractional system, there was an obvious improvement in 41% (7/17) of patients at 3 months' follow-up. Side effects were minimal and had mostly resolved by 3 months, and no patient suffered from obvious side effects. However, two patients still had minor or no improvement at 3 months. This may have resulted from individual variability. According to a recent study, the treatment appears to be more effective in younger patients with thin skin.¹⁷ However, no predictive factors could be identified before the treatment. These individuals might have needed higher treatment settings. In a small study comparing the efficacy and safety of a low-fluence, high-density CO₂ fractional system with those of high-fluence, low-density treatment for acne scars, the clinical results seemed to be more pronounced in the latter group.¹⁸

Fractional photothermolysis is an effective modality for the treatment of a variety of conditions, including photoaging and acne scarring, although the results have all been based on multiple treatments.^{6,10,11,19} Previous reports on CO₂ ablative resurfacing have involved at least three sessions.^{12,14,16,20} Cho et al studied the

Table 1 Degree of improvement evaluated by physicians at 1 month and 3 months post-treatment.

Degree of improvement	1 month	3 months
Grade 4 (76–100%)	0 (0%)	2 (12%)
Grade 3 (51–75%)	4 (16%)	5 (29%)
Grade 2 (26–50%)	16 (64%)	8 (47%)
Grade 1 (0–25%)	5 (20%)	2 (12%)
Total number of patients	25	17

Eight patients did not return for follow-up at 3 months after the treatment.



Figure 1 Atrophic and boxcar acne scars in a 24-year-old man before and after one session of fractional resurfacing using Deep FX therapy, 15 mJ with a density of 10%, showing moderate improvement; (A) right cheek, baseline; (B) right cheek, 1 month; (C) left cheek, baseline; (D) left cheek, 1 month.

effect of one session of CO₂ fractional photothermolysis on acne scars and conducted a split-face study comparing non-ablative 1550 nm erbium glass and ablative 10,600-nm CO₂ fractional photothermolysis treatments.^{11,13} Their small pilot study demonstrated the efficacy and safety of single-session acne scar treatment,

and the CO₂ fractional laser system was proven more effective than the fractional photothermolysis system.

However, in Cho et al's study, two treatment CO₂ fractional laser system modes (Deep FX and Active FX) were combined.¹¹ In another report by the same group, they indicated that adding one pass of

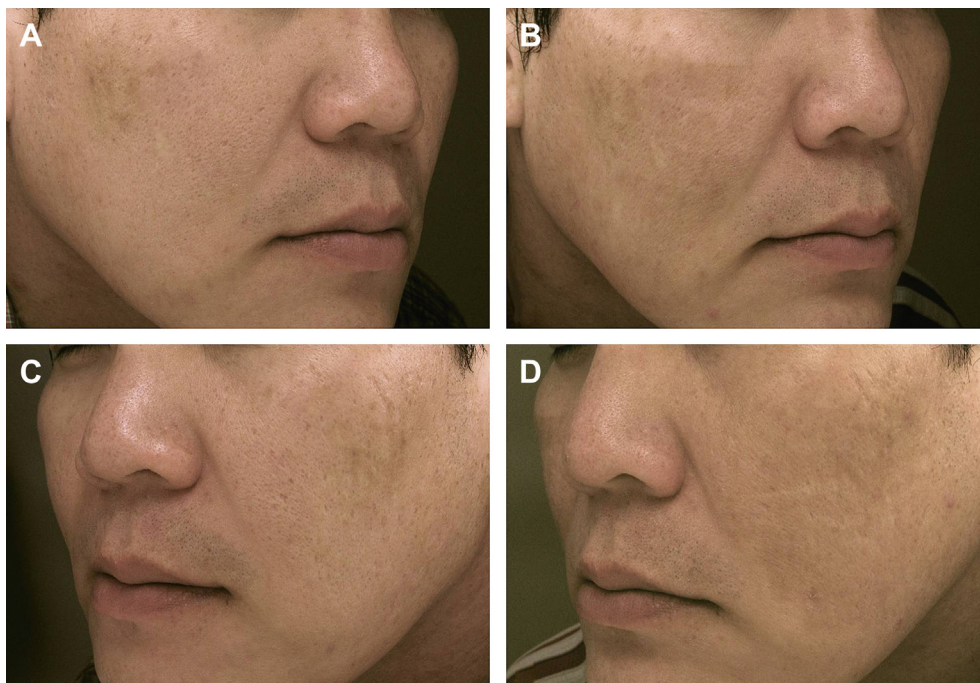


Figure 2 Boxcar and ice pick acne scars in a 28-year-old man before and after one session of fractional resurfacing using Deep FX therapy, 15 mJ with a density of 10%, showing moderate improvement; (A) right cheek, baseline; (B) right cheek, 3 months; (C) left cheek, baseline; (D) left cheek, 3 months.

Table 2 Degree of improvement evaluated by patients at 1 month and 3 months post-treatment.

Degree of improvement	1 month	3 months
Grade 4 (76–100%)	0 (0%)	2 (9%)
Grade 3 (51–75%)	3 (14%)	2 (9%)
Grade 2 (26–50%)	5 (24%)	6 (26%)
Grade 1 (0–25%)	17 (62%)	13 (56%) ^a
Total number of patients	25	23

Eight patients did not return for follow-up 3 months after treatment.

^a Six patients could be contacted by telephone (all of whom had been Grade 1 at 1 month follow-up) and stated that the results remained the same at 3 months; this information has been included in the table.

Active FX immediately after treatment with Deep FX significantly prolonged the post-treatment downtime from 2 days to 7 days.¹³ The prolonged recovery period therefore made this treatment protocol less acceptable than the fractional photothermolysis system. In contrast, we chose to use only one Deep FX pass with a spot size of 0.12 mm, which was more comparable to the healing process of the fractional photothermolysis system alone.

In our study, further improvement was reported subjectively (i.e., by patients and physicians) at 3 months compared to 1 month post-treatment. The objective evaluation by VISIA showed significant improvement in skin texture and pore number at 1 month but only minimal improvement at 3 months. In several patients with increased skin texture and pore scores, dry scaly surfaces were observed at 3 months, which may account for the worsening of the skin texture grade reported by patients at 3 months post-treatment. The dry, irregular surface may interfere with the VISIA evaluation, resulting in higher scores. Using an emollient containing glycyrrhetic acid silico-lactic complex for 2 days immediately following treatment effectively reduced the incidence of dry skin, which was a major complaint post-treatment.

In previous studies with three sessions of fractional CO₂ resurfacing, the improvement in skin texture and atrophy scars was greater at 3 months than at 1 month. However, the subjective improvement reported by these patients in the overall appearance of their acne scarring was lower at 3 months (2.0) than at 1 month (2.22).¹² The less obvious improvement by VISIA evaluation at 3 months in our study may be in part due to the use of only one treatment session, which resulted in a less sustainable effect than three sessions.¹⁴

The average level of improvement at 3 months (2.41) observed for our patients was similar to the findings of other studies (range

2.4–2.5).^{12,14} We also found a slight decrease in porphyria score at 1 month (–96.4, –55.2) but not at 3 months. Most patients experienced better control of their acne, with only three having an acne flare between 1 week and 1 month. There is currently still no consensus on the interval between treatment sessions. Based on our findings, if more than one treatment is to be given in order to achieve better long-term results, the interval between sessions could be 3 months. Shorter intervals may be adopted by non-responders.

The low incidence of PIH in our Asian patients also supports this recommendation. Although six (24%) of the 25 subjects displayed PIH at 1 month, it had faded by 3 months. Other studies of Asian patients have reported percentages of PIH at 3 months of between 0% and 13%.^{5,11,19} In one Asian study, patients reported an alarmingly high rate of PIH (92.3%) soon after treatment, but the condition resolved completely in all cases in an average of 5 weeks.¹⁶ We also observed this quick resolution. A lower incidence of PIH is reported in Caucasians following three treatments with a CO₂ fractional laser system. In one study, two of 15 patients had trace-to-mild PIH at the 3-month follow-up.¹² A similar study showed a 12% rate of PIH,¹⁴ comparable to the 10–12% incidence following mid-infrared fractional photothermolysis.²¹

The incidence of PIH may be more related to the density than the energy of the laser treatment.²² Based upon the low incidence of PIH in this study, we consider a density of 10–15% to be safe. At this density, however, either higher energy or a greater number of treatments may be required to achieve the desired cosmetic effect in low- or nonresponders.

We hope that by sharing the results of our treatment experiences, future studies can be conducted to define the range of safe and effective parameters in the treatment of atrophic acne scars in Asian patients.

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Table 3 Summary for the changes of the evaluated scores measured at 1 month and 3 months post-treatment.

Changes from baseline		1 month ^a (n = 24)	3 month ^a (n = 16)	p
Texture score	Right	–144.8 ± 133.1 [†]	86.4 ± 258.0	0.003*
	Left	–192.6 ± 251.6 [†]	165.1 ± 328.3	0.003*
Pore score	Right	–56.4 ± 70.3 [†]	14.5 ± 77.0	0.001*
	Left	–62.9 ± 91.0 [†]	58.7 ± 100.6 [†]	0.002*
Wrinkle score	Right	–0.9 ± 6.8	–0.9 ± 6.7	0.922
	Left	–0.1 ± 4.2	1.3 ± 5.3	0.029*
Pigment score	Right	4.8 ± 12.4	–0.3 ± 12.2	0.096
	Left	–3.2 ± 14.3	2.3 ± 14.3	0.570
Redness score	Right	26.3 ± 51.8 [†]	–14.4 ± 49.6	0.004*
	Left	19.9 ± 39.9 [†]	–10.4 ± 48.9	0.002*
Porphyria score	Right	–96.4 ± 218.3	–10.1 ± 183.8	0.464
	Left	–55.2 ± 265.8	10.8 ± 199.9	0.520

Data are presented as mean ± SD.

^a One patient did not have a VISIA score at 1 month, and nine patients had no VISIA score (8 did not return for follow-up) at 3 months, after treatment

* Significant difference in the corresponding data measured at 1 month and 3 months post-treatment

[†] Statistical significance was found compared with baseline.

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